in all untreated eyes to 6.4 percent in treated eyes after two years of follow-up. Based on these findings and the evaluation of various sub groups of diabetic retinopathy in the DRS, treatment is now being recommended for untreated eyes if the following conditions are present:

- Moderate to severe new vessels on or near the optic disk,
- Mild new vessels on or near the optic disk with associated vitreous or preretinal hemorrhage,
- Moderate to severe new vessels elsewhere on the surface of the retina if vitreous or preretinal hemorrhage is present.

It is apparent that while there is no cure for diabetic retinopathy, photocoagulation treatment applied to certain stages of this disease, according to the DRS protocol, is effective in reducing the incidence of severe visual loss. It should be stressed that the current recommendations for treatment are based on a preliminary report of two years' follow-up data after treatment. Evaluation of all patients in the study will continue and further analysis of the findings will be done to determine the long-term effectiveness of photocoagulation therapy, comparison between xenon arc and argon laser treatment, and the effect of this procedure in eyes with other degrees of retinopathy.

S. M. KOPELOW, MD

REFERENCES

Diabetic Retinopathy Study: Preliminary report on effects of photocoagulation therapy. Am J Ophthalmol 81:383-396, Apr 1976

Diabetic Retinopathy Study: Manual of Operations. Baltimore Diabetic Retinopathy Study Coordinating Center, 1972

Goldberg MF, Fine SL (Eds): Symposium on the Treatment of Diabetic Retinopathy—Publication 1890, US Public Health Service. San Francisco, Government Printing Office, 1969, ch 2

Visual Evoked Response

VISUAL EVOKED RESPONSE (VER) testing has been one of the most exciting clinical tools to be developed from neurophysiologic research in recent years and has provided us with an objective method of identifying abnormalities of the afferent visual pathways. More than thirty years ago it was shown that regularly repeated flashes of light before the eyes produced evoked responses in the electroencephalogram (EEG) recorded over the occipital cortex. However, in only a small number of people was there a visual evoked response because usually the response was so small it was lost in the random noise of the EEG (amplitude of largest VER waveform is only about 20 microvolts as compared with 500 microvolts for the electroretinogram (ERG). It was not until early in the 1960's that computers were developed that permitted averaging of an evoked response that was time locked to the stimulus. Thus, if a light flash was repeated rapidly 100 times before the eyes and the occipital EEG was recorded by a computer-averager, the common time-locked evoked response was added together to produce a clear wave form while the random EEG noise was slowly approximated to zero.

The stimulus often used to produce a VER is one hundred white flashes of light from a photostimulator. However, other investigators find that a more reproducible response is produced to a rapidly reversing black and white checkerboard pattern. Still other investigators use a straight pattern flash without pattern reversal. Thus one of the problems when reading VER literature is to know what stimulus is used (that is, flash, pattern reversal or pattern flash) and what that laboratory considers normal response.

The clinical usefulness of VER testing was heralded by Richey and co-workers (1971), Namerow and Enns (1972), Feinsod and associates (1973), and Halliday and associates (1973). They showed the frequent findings of an abnormally prolonged latency or an abnormal waveform in patients with multiple sclerosis who had no historical or clinical signs of visual system involvement. Often the abnormal VER will confirm a diagnosis of multiple sclerosis and prevent further expensive and painful neurologic testing.

VER has been clinically useful in several other ways. Malingerers who claim blindness in one or both eyes will produce a normal VER objectively refuting the patient's claim. On the other hand patients with posttraumatic subjective visual complaints without objective ophthalmologic signs may have an abnormal VER substantiating their complaints.

VER has been used to monitor optic nerve function during surgical removal of a pituitary adenoma compressing the chiasm. During surgical operation restoration of the normal VER pattern with removal of the tumor allowed the neurosurgeon to know when he had adequately decompressed the chiasm. Postoperatively the patient had a return to normal vision.

VER to an appropriate pattern reversal screen 6° in size has been shown to measure macular function and may be used to follow various forms of macular degeneration. VER abnormalities

shown by comparing homonymous field quadrants have been used to identify objectively field defects in patients with glaucoma. Rapid, objective refraction using VER has been possible and may prove clinically useful in the future.

Recently, waveform has begun to take on new importance in VER analysis. Attempts currently are being made to develop computer models of normal and abnormal waveforms. In addition, the use of color with various stimulus measurements is being investigated actively.

Some of the clinical applications to which VER has been applied are in the embryonic stages of development. The potential list of clinical applications of VER is endless. How many of these applications ultimately prove to be helpful remains to be seen. One fact seems certain—VER is here to stay as a valuable neuro-ophthalmologic tool.

JOHN L. KELTNER, MD

REFERENCES

Richey ET, Kooi KA, Tourtelotte WW: Visually evoked responses in multiple sclerosis. J Neurol Neurosurg Psychiatry 34: 275-280, Jun 1971

Namerow NS, Enns N: Visual evoked responses in patients with multiple sclerosis. J Neurol Neurosurg Psychiatry 35:829-833, Dec 1972

Feinsod M, Abramski O, Auerback E: Electrophysiological examinations of the visual system in multiple sclerosis. J Neurol Sci 20:161-175, Oct 1973

Halliday AM, McDonald WI, Mushin J: Visual evoked responses in diagnosis of multiple sclerosis. Br Med J 4:661-664, Dec 1973

Feinsod M, Hoyt WF, Wilson B, et al: Visually evoked response. Arch Ophthalmol 94:237-240, Feb 1976

Feinsod M, Selhorst JB, Hoyt WF, et al: Monitoring optic nerve function during craniotomy. J Neurosurg 44:29-31, Jan 1976

Sokol S: An electrodiagnostic index of macular degeneration. Arch Ophthalmol 88:619-624, Dec 1972

Cappin JM, Nissim S: Visual evoked responses in the assessment of field defects in glaucoma. Arch Ophthalmol 93:9-18, Jan 1975

Regan D: Rapid objective refraction using evoked brain potentials. Invest Ophthalmol 12:669-679, Sep 1973

Advances in Glaucoma Management (Including Laser Treatment)

GLAUCOMA is an optic neuropathy associated with an elevated intraocular pressure leading to cupping of the optic disc and a loss of visual field. Therapy in glaucoma is aimed at reducing the intraocular pressure by decreasing the flow of fluid into the eye or by increasing the flow rate of fluid leaving the eye. Medical therapy, including the use of eye drops and orally given medications, are the first line of defense in glaucoma management. When medical therapy fails to halt the progression of nerve damage and field loss, surgical therapy is undertaken. As medical therapy is intensified or surgical therapy applied, the risks and complications of therapy increase and can affect not only the eye, but the body in general. There is a constant search for therapies that have increased effectiveness and safety in the management of glaucoma.

Examples of some of the new techniques include continuous ocular therapeutic systems. These devices contain medications that are metered out a small amount at a time resulting in drug effect without the transient overdose associated with the pulsed delivery of drugs such as with the use of eye drops. This results in a more even effect, lowered total dose, and reduced local and generalized side effects of the medication. However, this form of therapy cannot be used in all patients.

New classes of drugs that work in new ways also offer hope for the glaucoma patient. These include beta-adrenergic blocking agents and derivatives of the marijuana plant. Studies of these drugs are still investigational and thus such medication is not generally available but results of preliminary studies are certainly encouraging.

Microsurgical techniques have increased the safety of surgical operation for glaucoma by allowing better control during the operation. Microsurgery also has increased the variety of operations the surgeon can use thereby making it possible to fit a specific operation to a specific patient.

Laser therapy for glaucoma has been used for angle closure or sudden onset glaucoma as well as open angle glaucoma. A finely focused beam of laser light can be used to create a hole in the iris thus avoiding the need for surgical procedures in patients who are candidates for the usual operation of peripheral iridectomy. Investigations also are underway using laser in the treatment of open-angle glaucoma and in neovascular glaucoma associated with diabetes. In both of these latter cases, the laser beam is directed to the area where fluid normally leaves the eye, the trabecular meshwork.

DAVID M. WORTHEN, MD

REFERENCES

Lee P, Shen Y, Eberle M: The long acting ocusert-pilocarpine system in the management of glaucoma. Invest Ophthalmol 14: 43-46, Jan 1975

Katz IM, Hubbard WA, Getson AJ, et al: Intraocular pressure decrease in normal volunteers following timolol ophthalmic solution. Invest Ophthalmol 15:489-492, Jun 1976

Green K: Marijuana and the eye (Editorial). Invest Ophthalmol 14:261-263, Apr 1975

Dannheim R: Symposium—Microsurgery of the outflow channels. Trans Am Acad Ophthalmol Otolaryngol 76:375-383, Mar-Apr 1972

Kaufman HE, Zimmerman T: Current Concepts in Ophthalmology—Vol 5. St. Louis, CV Mosby Company, 1976, p 297

Simmons RJ: Goniophotocoagulation for neovascular glaucoma. Trans Am Acad Ophthalmol Otolaryngol 81:Ophthalmology-123, Jan-Feb 1976